10/586207
IAP20 Rec'd PCT/PTO 13 JUL 2006

MODULE WITH NON-DEFORMABLE SUPPORT FOR FILTER SEPTA AND MEMBRANE TYPE FILTER ELEMENTS

TECHNICAL FIELD AND BACKGROUND ART

This invention refers to a module for filter septa and membrane type elements according to the introduction of the main claim.

Micro-filtering, ultra-filtering, nano-filtering and reverse osmosis technology is implemented with different types of modules, the most efficient and less cumbersome of which are those of the membrane type.

Micro-filtering is a process that uses a membrane able to remove all particles with the diameter of between 0.1 and 1 micron and above. More generally, this type of membrane removes particles in suspension and large colloidal species, while macro-molecules and saline species pass through untreated; the difference in pressure between the upstream and downstream points of the membrane (cross-membrane pressure) is typically between zero and 3-4 bar.

Ultra-filtering is a process based on the use of a membrane able to remove all the particles as in the previous case and also all organic substances within a molecular weight of between 1000 to approx. 100000.

Ultra-filtering does not trap ionic species and the cross-membrane pressure is generally between 1 and 7 bar.

Nano-filtering is a process based on the use of a membrane able to remove all particles in suspension, all organic substances with a

molecular weight of more than 300 and ionic species, selectively the bivalent (such as for example calcium, magnesium and sulphates) at 75-85% and monovalent (sodium, nitrates, chlorides) at 55-65%. The cross-membrane pressure ranges approximately from 3 to 16 bar.

Reverse osmosis which, strictly speaking, cannot be considered a real filtering technique, is a process that also uses a membrane able to remove all the particles in suspension, all organic substances with a molecular weight above 200 and all ionic species from 98 to 99.8%. The cross-membrane pressure is usually between 7 and 84 bar.

Below in this patent, to simplify description, the generic term "filtering" will be used to indicate micro-filtering, ultra-filtering, nano-filtering and reverse osmosis. The generic term "filter membrane" or simply "membrane" will indicate the filter septum used for micro-filtering, for ultra-filtering and for nano-filtering and also the membrane used for reverse osmosis.

The flow of fluid treated by a module is basically proportional to the surface of the filter membrane. Therefore, the aim of whoever designs a filter or reverse osmosis module is to maximise the surface of the membrane while reducing overall dimensions to a minimum. It can be said that the flow of fluid that passes through the filter membrane is also proportional to the difference in pressure between the points upstream and downstream of the membrane (cross-membrane pressure) whereby, as the filter membranes have a limited

mechanical resistance, particular measures are necessary to avoid breakage. Another primary objective for whoever designs a module is that of ensuring that the membrane can be washed easily and effectively for optimal regeneration of the module and to extend its service life. The modules for filter septa and membrane elements available today on the market are of four main types: tubular, flat wall, spiral-wound and hollow fibre. Of these, the module with the most favourable filter surface/volume ratio is the spiral-wound type in which, in order to obtain large filtering surfaces and reduced overall dimensions, a membrane, a screen of plastic material and a sheet of impermeable material are overlapped in this order and rolled in order to form a spiral. The plastic screen is designed to create a passage for the fluid to be treated.

The fluid to be treated enters from the base of the cylindrical pack that forms the spiral, flowing between the cavities produced by the presence of the screen, through the membrane and, once treated, is blocked by the impermeable sheet and forced to move tangentially so that it reaches the centre of the spiral where it is collected by the tube around which the spiral is wound.

In flat wall modules, the filter membrane, of circular crown shape, rests on a support of the same shape. The fluid to be treated usually impinges on the membrane and the treated fluid collected on the opposite side flows out of the module in a radial direction. In this case, the relationship between the filtering surface and the volume of the module is considerably less favourable compared with the spiral-

wound version.

Tubular and hollow fibre modules are characterised by a multitude of tubes or hollow fibres inside which the fluid treated is collected while the fluid to be treated is on the outside.

One of the problems of spiral-wound modules is that the lengthwise movement of the fluid is considerably obstructed by the meshes of the plastic screen which is, however, necessary to create a cavity through which the fluid to be treated can flow. As a result, the part of the filter membrane closest to the inlet of the fluid to be treated works better and more than the most distant part.

A second problem of the spiral-wound modules, also common to all the other modules, is that washing is not very effective and almost impossible due to the large number of undercuts formed by the mesh of the screen. To restrict the need for washing to a minimum, another coarser filter system is provided ahead of the filter plant with a consequent considerable increase in costs.

DISCLOSURE OF INVENTION.

Therefore, the aim of this invention is to construct a reduced-size module that makes it possible to manage high level flows of fluid, to use a large surface membrane and which, at the same time, permits easy, efficient washing of the membrane. This purpose is achieved by a module, the characteristics of which are highlighted in the claims.

BRIEF DESCRIPTION OF DRAWINGS.

Understanding of the invention will be facilitated by the following

detailed description, provided for example purposes only and not therefore restrictive, of three preferred embodiments illustrated in the attached drawings, in which:

- Figure 1 is a schematic view of the lengthwise cross-section of the module in its preferred embodiment,
- Figure 2 is a view of the base of one of the prismatic elements forming the non-deformable support in its preferred embodiment;
- Figure 3 is an enlargement of one end of two overlapped prismatic elements;
- Figure 4 is a prospect view of the non-deformable support in a second embodiment;
- Figure 5 is a prospect view of a third embodiment of the non-deformable support;
- Figure 6 shows a fourth embodiment of the non-deformable support.

BEST MODE FOR CARRYING OUT THE INVENTION.

With reference to figure 1, the module according to this invention, in its preferred embodiment, includes a container 1 with at least an entrance hole 2 for the fluid to be treated and an outlet hole 3 for discharge of the fluid treated, a drainage hole 4, a non-deformable support 5 and a filter membrane 6 suitably rested on the side surface of the non-deformable support 5. The non-deformable support 5 includes two or more prismatic elements 7 all identical, stacked on each other, each with at least a lengthwise movement hole 8 for outflow of the fluid treated and at least another two or more

lengthwise holes 9 for alignment. The prismatic elements of the stack may be tightened, for example, using bolts screwed onto guide rods with suitably threaded ends, that extend into such lengthwise alignment holes 9. Bases 11 and 12 of the non-deformable support 5 are sealed by two plugs 13 and 14 that prevent passage of the untreated fluid through the bases 11 and 12. At least one of the two plugs 13 and 14 has a hole to permit connection, via the tube 15, to the outlet hole 3 for discharge of the fluid treated.

With reference to figure 2, the prismatic elements 7 that, stacked, form the non-deformable support 5, are of prismatic shape with a basically star-shaped base with rounded angles and cylindrical-shaped external side surface 16 on which the filter membrane 6, with high level roughness, regular or irregular, rests. The surface 17 of the upper and lower bases of each of these prismatic elements 7 is characterised by ducts or knurling that, from the side surface 16, lead to the centre of the support where the movement duct for outflow of the fluid treated is present, such duct consisting of the set of lengthwise holes 8 of such prismatic elements 7.

Figure 3 shows the detail of the end of two overlapped prismatic elements 7. The side surface 16 is rough while the surface 17 of the upper and lower bases is characterised by ducts or knurling that, preventing perfect contact between the bases of the two overlapped prismatic elements 7, allows the treated fluid to move towards the lengthwise movement hole 8 for outflow of the fluid treated.

Membrane 6, suitably fluted and with the two non-fluted terminal

edges glued together to form a closed cylindrical surface, rested on the external rough side surface of the non-deformable support 5, is sealed in an airtight manner against the side surface of the non-deformable support 5 along its edges in the vicinity of the bases 11 and 12 of the non-deformable support 5. In operation, the rectangular-sheet-shaped membrane 6 is suitably fluted, the two opposite edges are glued to form a cylinder with the star-shaped base, it is inserted on the non-deformable support 5, bases 11 and 12 of which are immersed in a sealing material or a molten plastic material that wets the edge of the filter membrane. Practically speaking, a two-component sealant has been used that is available on the market with the name Polyprom 03 and Polycomp 40. Using this procedure, once the sealing material has solidified, it forms the two plugs 13 and 14 that guarantee correct seal of the membrane and prevent infiltrations of untreated fluid via the lengthwise outlet duct through the upper and lower bases 11 and 12 of the non-deformable support 5.

Container 1 is intended to contain the fluid to be treated and to permit application of the necessary pressure on the fluid so as to force passing of this through the membrane 6.

The fluid to be treated fills the container 1, presses on the outer surface of the filter membrane 6 which therefore rests on the rough area of the side surface 16, passes through the membrane 6, flows between this and the very rough side surface 16 of the non-deformable support 5 until it reaches the contact surface between the

base 17 of one prismatic element 7 and the next. The presence of ducts on the upper and lower surfaces of these prismatic elements 7 causes imperfect contact between these surfaces and therefore permits movement of the fluid along the ducts as far as the lengthwise movement hole 8 for outflow of the treated fluid connected with the outfeed hole 3. These ducts may be afforded by knurling of the surface or high-level roughness.

If high pressure on the fluid to be treated is not necessary in order to force passing of this through the membrane, the container 1 could also not be present, meaning that the module works at a vacuum. For example, the module, without the container 1, can be simply immersed in the fluid to be treated and the movement duct connected to a pump that, creating a vacuum, draws up the treated fluid.

The particular shape of the non-deformable support 5 permits easy, efficient washing of the surface of the filter membrane, for example through the mechanical action of a jet of water or detergent.

For this purpose, it is advantageous that the non-deformable support 5 may be rotated for example by a motor connected to this.

Preferably, the non-deformable support 5 must not have sharp edges on the side surface to avoid cutting or damage to the filter membrane that rests on this. Also, for the same reason, it is preferably made of plastic material such as for example ABS, polypropylene, polystyrene and similar materials. Very rough surfaces or surfaces with ducts or knurling, necessary for functioning of the non-deformable support 5, can be obtained advantageously through

electro-erosion of the metal mould used to construct the component prismatic elements 7.

According to a particular aspect of the invention, a screen or wires for example made of plastic material, or a sheet of material permeable to the fluid, can be inserted between the non-deformable support 5 and the membrane 6 and also between the bases 17 of two contiguous prismatic elements 7, in order to create a space between the side surface 16 of the non-deformable support and the filter membrane 6 or between two contiguous prismatic elements within which the fluid treated may flow. In this case, both the side surface 16 and the surface of the bases 17 of the prismatic elements 7 may be smooth and therefore without roughness, ducts or knurling.

Figure 4 shows a second embodiment of the non-deformable support 105 of a module for filter septa and membrane elements. In this second embodiment, the non-deformable support 105 consists of prismatic elements 107 including a lengthwise movement hole 108 of the fluid with star-shaped or undulated cross-section. In this case, the filter membrane is placed inside the lengthwise movement hole 108 where the fluid to be treated arrives while the treated fluid is collected outside or by further lengthwise holes in the non-deformable support. The advantage of this second embodiment is that it does not require an external container for pressurisation of the fluid to be treated and it has a more compact, resistant external shape.

According to a third embodiment of the invention, the non-

deformable support, instead of including a set of overlapped and aligned prismatic elements that permit flowing of the treated fluid between the grooved surfaces of the bases in contact, consists of a porous material or material permeable to the fluid, for example due to the presence of a multitude of small-diameter holes. Figure 5 illustrates the case in which this non-deformable support 205 consists of a metal sheet 218 of suitable thickness with a star-shaped straight section and equipped with a plurality of small-diameter holes 219 on the surface.

According to a particular aspect of the invention shown in figure 6, the non-deformable support 305 may have an undulated cylindrical side surface with any cross-section, also not closed and not necessarily star-shaped or axial-symmetric. For example, this non-deformable support 305 could have the appearance of a non-deformable undulating septum that, inserted crosswise in a duct, filters the fluid flowing in this. The cylindrical surface with star-shaped straight section has the advantage of being easily washable by jets of liquid sprayed by fixed nozzles while the non-deformable support is rotated.

As the non-deformable support is of undulated shape, the filter surface is very high, volume is reduced, washing of the membrane is simple and efficient, making it possible therefore to eliminate or considerably reduce the need for expensive pre-filtering units upstream.

As any membrane can be placed on the non-deformable support, the

module is readily adaptable for use for any type of filtering, also and especially the membranes used for micro-filtering, ultra-filtering, nano-filtering and reverse osmosis. Also, the module can, simply replacing the membrane, be used for different types of filtering or treatments or can be gradually equipped with membranes that are the state-of-the-art of sector technique.

The fact that the non-deformable support includes several prismatic elements means that the module can be adapted to use different height membranes.

The module can be constructed so as to include a water jet washing system. In this case, the non-deformable support is advantageously connected to a motor that rotates it slowly for washing of the entire surface.

The term "basically undulating contour", as used here, also includes undulating contours characterised by dips and crests with more or less regular borders.

The term "cylindrical surface" or "cylindrical side surface", as used herein, means a surface formed by all parallel generating lines and any straight section, also open and therefore not forming a closed line.